

FAIRNESS IN WIRELESS NETWORKS WITH ADAPTIVE CLEAR CHANNEL ASSESSMENT THRESHOLDS

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to provisional U.S. patent application Ser. No. 62/218,183 filed on Sep. 14, 2015, the entire contents of which are hereby incorporated by reference.

TECHNOLOGICAL FIELD

[0002] The described invention relates to wireless communications, and more particularly to procedures by which multiple users/nodes contend for access to a radio channel, such as for example carrier sense multiple access with collision avoidance (CSMA/CA) in Wi-Fi or other radio access technologies.

BACKGROUND

[0003] The exponential increase in the number of mobile users and devices (smart phones, tablets, etc.) and the emerging technologies (e.g., Internet of Things (IoT), digital health, and immersive multimedia) create a substantial challenge to the design of the next generation wireless local area networks (WLANs). The volume of mobile data traffic is also growing rapidly; it is estimated that over $\frac{2}{3}$ of mobile data traffic will be video by the year 2018. These factors are expected to cause a spectrum crisis known colloquially as the 1000x challenge, where the wireless demand on the year 2020 is expected to be 1000x greater than the demand in 2010.

[0004] When multiple users contend for available radio resources (typically time and frequency) in a specific geographic area, media access control (MAC) protocols are typically used to organize the communication process between nodes/users and the radio access node (in the case of centralized systems, such as the AP in WLAN systems) or communications directly among the users/nodes (in the case of distributed or ad hoc systems). Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA, also referred to as the distributed coordination function (DCF) or more informally as listen-before-talk), is a widely used MAC protocol based on random channel access. Stations (STAs) perform a clear channel assessment (CCA) to check that the channel is clear before transmitting. In this regard the following documents explore how to allow the CCA to be adaptive for use in future WLAN systems such as IEEE 802.11ax to better accommodate the expected increase in users and traffic volume.

[0005] *Legacy Fairness Issues of Enhanced CCA* (doc. IEEE 802.11-15-0085r1; January 2015) by John Son, Geonjung Ko and Jin Sam Kwak (<https://mentor.ieee.org/802.11/dcn/15/11-15-0085-01-00ax-legacy-fairness-issues-of-enhanced-cca.pptx>, last visited Aug. 25, 2015);

[0006] System and method for determining a clear channel assessment threshold (WO 2015089229; Jun. 18, 2015) by Lukasz Krzymien, George Calcev, Lin Cai and Hanan Ahmed;

[0007] *CSMA Self-Adaptation based on Interference Differentiation* (Global Telecommunications Conference, 2007; 26-30 Nov. 2007) by Jing Zhu, Xingang Guo, Sumit Roy and Konstantina Papagiannaki; (http://www.ee.washington.edu/research/funlab/Publications/2007/2007_jing_csma_self_adaptation_CCA_PW_self_Globe-com07.pdf, last visited Aug. 25, 2015);

washington.edu/research/funlab/Publications/2007/2007_jing_csma_self_adaptation_CCA_PW_self_Globe-com07.pdf, last visited Aug. 25, 2015);

[0008] *Impact of TPC coupled to DSC for legacy unfairness issue* (doc. IEEE 802.11-15/0319r1; March 2015) by Takeshi Itagaki, Masahito Mori, Tsuguhide Aoki, Koichi Ishihara, Shoko Shinohara and Yasuhiko Inoue (<https://mentor.ieee.org/802.11/dcn/15/11-15-0319-01-00ax-impact-of-tpc-coupled-to-dsc-for-legacy-unfairness-issue.pptx>), last visited Aug. 25, 2015);

[0009] *TG ax DSC Summary* (doc. IEEE 802.11-15-0807r2; July 2015) by Graham Smith (<https://mentor.ieee.org/802.11/dcn/15/11-15-0807-02-00ax-dsc-summary.pptx>), last visited Aug. 25, 2015);

[0010] *Further Considerations on Legacy Fairness with Enhanced CCA* (doc. IEEE 802.11-15/0374r1; Mar. 10, 2015) by John Son, Geonjung Ko, Jin Sam Kwak, Young Doo Kim and Hong Seok Shin (<https://mentor.ieee.org/802.11/dcn/15/11-15-0374-01-00ax-further-considerations-on-legacy-fairness-with-enhanced-cca.pptx>), last visited Aug. 25, 2015); and

[0011] *OBSS reuse mechanism which preserves fairness* (doc. IEEE 802.11-15/1207r1; September, 2014) by Imad Jamil, Laurent Cariou and Thomas Derham (<https://mentor.ieee.org/802.11/dcn/14/11-14-1207-01-00ax-obss-reuse-mechanism-which-preserves-fairness.ppt>), last visited Aug. 25, 2015).

SUMMARY

[0012] In accordance with a first embodiment of these teachings there is a method in which an apparatus selects a first clear channel assessment threshold that is higher than a minimum clear channel assessment threshold; determines to temporarily use a second clear channel assessment threshold that is lower than the first clear channel assessment threshold; and based on that determining it selects the second clear channel assessment threshold for a specified time period.

[0013] In accordance with a second embodiment of these teachings there is an apparatus comprising at least one processor and at least one non-transitory memory including computer program code. In this second embodiment the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to select a first clear channel assessment threshold that is higher than a minimum clear channel assessment threshold; to determine to temporarily use a second clear channel assessment threshold that is lower than the first clear channel assessment threshold; and based on said determining to select the second clear channel assessment threshold for a specified time period.

[0014] In accordance with a third embodiment there is a computer readable memory tangibly storing computer program code. This stored computer program code, when executed by one or more processors of an apparatus, causes the apparatus to select a first clear channel assessment threshold that is higher than a minimum clear channel assessment threshold; determine to temporarily use a second clear channel assessment threshold that is lower than the first clear channel assessment threshold; and based on said determining causes the apparatus to select the second clear channel assessment threshold for a specified time period.